PATENT APPLICATION

IN THE U.S. PATENT AND TRADEMARK OFFICE

September 12, 2007

Applicants: Hideo SANO et al

For: METHOD OF MANUFACTURING HIGH-STRENGTH ALUMINUM ALLOY EXTRUDED PRODUCT EXCELLING IN CORROSION RESISTANCE AND STRESS CORROSION CRACKING RESISTANCE

Serial No.: 10/666 216 Group: 1742

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Commissioner for Patents
P.O. Box 1450
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DECLARATION UNDER 37 CFR 1.132

I, the undersigned, hereby declare as follows:

I am one of the inventors of the invention described and claimed in application Serial No. 10/666 216, filed on September 18, 2003.

I hereby incorporate by reference herein the contents of the Examples and Comparative Examples contained in application Serial No. 10/666 216.

I have performed additional tests to illustrate the criticality of the inner circumferential surface of the guide hole of the flow guide being separated from an outer circumferential surface of an orifice which is continuous with the bearing of the solid die at a distance of 9-15mm.

TEST PROCEDURE

An aluminum alloy having the composition shown in the below Table 1 was cast by semi-continuous casting to prepare billets with a diameter of 100 mm. The billets were homogenized at 530°C for 8 hours and cooled from 530°C to 250°C at an average cooling rate of 250°C/h to prepare extrusion billets.

Table 1

Alloy Composition (mass%)					
Si	Mg	Cu	Mn	Cr	Al & Impurities
0.9	1.0	1.7	0.8	0.2	Bal

The extrusion billets were heated at 520°C and extruded by using a solid die at an extrusion ratio of 27 and an extrusion speed of 6 m/min to obtain solid extruded products having a rectangular profile of 12 mm thickness by 24 mm width. The solid die had a bearing length of 6 mm and the corners of its orifice were rounded off with a radius of 0.5 mm. A flow guide attached to the die had a rectangular guide hole with a distance (A) from the inner circumferential surface of the guide hole to the outer circumferential surface of the orifice set at 4 mm, 5 mm, 9 mm, 12 mm, 15 mm and 17 mm, respectively, and a thickness (B) of the flow guide set at 15 mm with respect to the billet diameter of 100 mm. (B=15% of the billet diameter). The solid extruded products obtained were solution treated at 540°C, and water-quenched within 10 seconds after the solution heat treatment. After 3 (three) days after completion of the quenching, an artificial aging (tempering) at 175°C for 8 hours was made to refine the quenched products to T6 temper condition.

TEST RESULTS

The properties of the T6 temper material obtained were evaluated by (1) a measurement of properties of the area ration of a fiber structure in the transverse cross section, (2) a tensile test, (3) an intergranular corrosion test and (4) a stress corrosion cracking test mentioned below. The test results are summarized in Table 2.

(1) Measurement of area ratio of fiber structure: The area of a fiber structure in the transverse cross

section was measured by using an image analyzer and its ratio (%) to the total area was calculated.

(2) Tesile test: Ultimate tensile strength (UTS), yield strength (YS) and elongation (δ) were measured in accordance with JIS Z 2241.

(3) Intergranular corrosion test: A test solution was prepared by dissolving 57 grams of sodium chloride (NaCl) and 10 ml of 30% aqueous hydrogen peroxide (H_2O_2) into distilled water to make a total of 1 liter solution. Each specimen was immersed in the test solution at 30°C for 6 hours, and the corrosion weight loss was measured. A specimen showing a weight loss of less than 1.0% was judged as having good corrosion resistance.

(4) Stress corrosion cracking test: Based on the test specified in JIS H 8711 using a C-ring test piece (28 mm in diameter, 2.2 mm in thickness), the time to fracture at a stress of 350 MPa was measured. A specimen showing no cracking at 700 hours was judged as having good stress corrosion cracking resistance.

Table 2

Specimen	A (mm)	Area ratio of fiber structure (%)	UTS (MPa)	YS (MPa)	δ (%)	Corrosion weight loss (%)	Stress corrosion cracking time (h)
1	4	54	280	160	5	--	--
2	5	62	405	365	10	0.8	>700
3	9	70	430	385	11	0.6	>700
4	12	82	440	405	12	0.4	>700
5	15	90	445	408	12	0.3	>700
6	17	92	448	414	13	0.3	>700

DISCUSSION OF RESULTS

Specimen 1 was extruded using a flow guide with an insufficient dimension for the distance A. As a result, the

aluminum alloy billet was extruded under an excessively high temperature and it led to recrystallization in the surface layer which prevented the material from obtaining satisfactory strength. Since the extruded product developed cracks, the intergranular corrosion test and the stress corrosion cracking test could not be performed.

Specimen 2 was extruded using a flow guide with a distance A of 5 mm. An extruded product with a fiberous structure of 62% in area-fraction of the cross-sectional structure was obtained. It had a good strength, corrosion resistance and stress corrosion cracking resistance.

Specimen 3 was extruded using a flow guide with the distance A of 9 mm and an extruded product with an increased area-fraction (70%) of a fiberous structure was obtained. It had an excellent strength, corrosion resistance and stress corrosion cracking resistance in comparison with Specimen 2.

Specimen 4-6 were extruded using flow guides with a distance A of 12 mm, 15 mm and 17 mm, respectively. The extruded products had a further increased area-fraction (82%, 90% and 92%, respectively) of a fiberous structure and more excellent strength, elongation and corrosion resistance in comparison with Specimen 3.

As mentioned above, it has been proved that:

By using a flow guide with the distance A of 5 mm or more, which is the distance between the inner circumferential surface of the guide hole inside the flow guide at the front of the solid die and the outer circumferential surface of the orifice of the solid die, an extruded product with a fiberous structure of 60% or more in area-fraction of the cross-sectional structure of the product was obtained which led to a good strength, corrosion resistance and stress corrosion cracking resistance of the extruded product.

By using flow guides with a distance A of 9-17 mm, the extruded products had further an increased area-fraction (70%-92%) of fiberous structure, which led to an excellent strength, elongation and corrosion resistance in comparison

with using a flow guide with a distance A of 5 mm, together with an excellent stress corrosion cracking resistance.

It was also confirmed that when a flow guide with a distance A over 15 mm, for example 17 mm, was used, there was the following problem. When a successive billet was supplemented to a former billet for a continuous extrusion, the end of the former billet was cut. In this case, the end of the former billet was easy to deform. As a result, when the successive billet was supplemented to the end of the former billet and was extruded, air tended to be captured where the two billets were joined, which led to an increase in inferior parts of the product and decrease of yield rate. Therefore, it is preferable that the distance of A is 9-15 mm.

I hereby declare that all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true; and further, that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Dated: September 20, 2007 Hideo Sano

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